West coast of Newfoundland capelin (*Mallotus villosus* M.) and Atlantic herring (*Clupea harengus harengus* L.) larval survey, part 3: Description of the data collected in partnership with the industry (Barry Group) in July 2005

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WEST COAST OF NEWFOUNDLAND CAPELIN (*Mallotus villosus* M.) AND ATLANTIC HERRING (*Clupea harengus harengus* L.) LARVAL SURVEY, PART 3: DESCRIPTION OF THE DATA COLLECTED IN PARTNERSHIP WITH THE INDUSTRY (BARRY GROUP) IN JULY 2005

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TABLE OF CONTENTS

LIST OF TABLES iv

LIST OF FIGURES iv

LIST OF APPENDICES v

ABSTRACT / RÉSUMÉ vi

INTRODUCTION 1

MATERIAL AND METHODS 1

RESULTS 2

ACKNOWLEDGEMENTS 2

REFERENCES 2

LIST OF TABLES

Table 1. Description of the stations and tows completed during the capelin and Atlantic herring larval survey of July 2005 4

Table 2. Mean water temperature (°C) by depth interval (m) for the stations sampled during the capelin and Atlantic herring larval survey of July 2005 5

Table 3. Mean water salinity by depth interval (m) for the stations sampled during the capelin and Atlantic herring larval survey of July 2005 7

Table 4. Descriptive statistics of the length measurements (mm) of capelin (A) and Atlantic herring (B) larvae sampled during the July 2005 survey 9

LIST OF FIGURES

Figure 1. Map of the west coast of Newfoundland showing the study area and the other locations mentioned in the document 11

Figure 2. Map of the 39-station sampling grid of the capelin and Atlantic herring larval survey of July 2005 12

Figure 3. Mean water temperature (°C) by depth intervals of 2 m from 0 m to 20 m and intervals of 5 m between 20 m and 60 m 13

Figure 4. Length (mm) frequency distributions of capelin and Atlantic herring larvae sampled during the July 2005 survey 16

LIST OF APPENDICES

Appendix 1. Temperature profiles for stations sampled during the capelin and Atlantic herring larval survey of July 2005 on the west coast of Newfoundland.....17

Appendix 2. Volume of the plankton sample (ml) and number of eggs sorted and identified from the samples collected during the capelin and Atlantic herring larval survey of July 2005 on the west coast of Newfoundland 25

Appendix 3. Number of larvae sorted and identified from the samples collected during the capelin and Atlantic herring larval survey of July 2005 on the west coast of Newfoundland.....28

ABSTRACT

Grégoire, F., W. Barry, J. Barry, L. Lefebvre, C. Lévesque, and J. Hudon. 2006. West coast of Newfoundland capelin (*Mallotus villosus* M.) and Atlantic herring (*Clupea harengus harengus* L.) larval survey, part 3: Description of the data collected in partnership with the industry (Barry Group) in July 2005. Can. Data Rep. Fish. Aquat. Sci. 1168(Part3): vi + 32 pp.

In partnership with the Barry Group in Corner Brook, a larval survey was conducted from July 19 to 21, 2005, between Bonne Bay and Port au Port Bay on the west coast of Newfoundland. Fish eggs and larvae were found at all the sampled stations. The two most abundant groups of eggs that were identified were CYT (cunner [*Tautogolabrus adspersus*] and yellowtail flounder [*Limanda ferruginea*]) and CHW (cod [*Gadus morhua*], haddock [*Melanogrammus aeglefinus*], and witch flounder [*Glyptocephalus cynoglossus*]). Mackerel eggs (*Scomber scombrus*) were also found at each station. Of the sixteen species of larvae identified, the most abundant were those of cunner, fourbeard rockling (*Enchelyopus cimbrus*), capelin (*Mallotus villosus*), righteye flounder (Pleuronectidae), and cod. Depth-based profiles of water temperature and salinity were made for each station. All the biological and oceanographic data collected during the survey were compiled and are presented in the tables, figures, and appendices found in this document. These data will be analyzed and published in a forthcoming report.

RÉSUMÉ

Grégoire, F., W. Barry, J. Barry, L. Lefebvre, C. Lévesque, et J. Hudon. 2006. West coast of Newfoundland capelin (*Mallotus villosus* M.) and Atlantic herring (*Clupea harengus harengus* L.) larval survey, part 3: Description of the data collected in partnership with the industry (Barry Group) in July 2005. Can. Data Rep. Fish. Aquat. Sci. 1168(Part3): vi + 32 pp.

En partenariat avec le Groupe Barry de Corner Brook, un relevé larvaire a été réalisé du 19 au 21 juillet 2005 entre les baies de Bonne Bay et de Port au Port de la côte ouest de Terre-Neuve. Des œufs et des larves de poissons ont été retrouvés à toutes les stations échantillonnées. Les deux plus abondants groupes d'œufs qui ont été identifiés sont CYT (tanche-tautogue [*Tautogolabrus adspersus*] et limande à queue jaune [*Limanda ferruginea*]) et CHW (morue [*Gadus morhua*], aiglefin [*Melanogrammus aeglefinus*] et plie grise [*Glyptocephalus cynoglossus*]). Des œufs de maquereau (*Scomber scombrus*) ont aussi été retrouvés à toutes les stations. Des seize espèces de larves identifiées, les plus importantes sont celles de la tanche-tautogue, de la motelle à quatre barbillons (*Enchelyopus cimbrus*), du capelan (*Mallotus villosus*), de la plie (Pleuronectidae), et de la morue. Des profils de la température et de la salinité de l'eau en fonction de la profondeur ont été réalisés à chaque station. Toutes les données biologiques et océanographiques recueillies lors du relevé ont été compilées et sont présentées dans les tableaux, figures et annexes du présent document. Ces données seront analysées et publiées dans un rapport à venir.

INTRODUCTION

In collaboration with the industry, a plankton survey was done on the west coast of Newfoundland in July 2004. The objective was to collect basic information on the distribution and abundance of capelin and herring larvae found in an active fishing area located close to the coast, between Bonne Bay and Port au Port Bay (Figure 1). This area of the west coast of Newfoundland had never before been covered by this type of survey. During the survey, the eggs from three species and three groups of species were identified as well as the larvae from 20 species (Grégoire et al. 2005). The average abundances of capelin and herring larvae were estimated, and various biodiversity measurements indicated that the larval community structure in the sampled area was characterized by the occurrence of a large number of scarce species and by commercial species concentrated in specific locations (Grégoire et al. 2006).

A second plankton survey was realized in July 2005, again with the financial and logistic support of the Barry Group. The objective and the sampling area were the same.

The present report compiles and documents the biological and oceanographic data collected during the 2005 survey. The detailed analysis of these data will be presented in a forthcoming report.

MATERIAL AND METHODS

Plankton sampling was made by the *Ocean Provider*, a large seiner from the west coast of Newfoundland. The sampling procedures were the same as those performed in 2004. At each station, plankton was collected using a 61-cm bongo sampler equipped with two nets lined with 333-micron and 500-micron mesh, respectively (Posgay and Marak, 1980). A General Oceanics flowmeter was placed at the opening of each net to measure the volume of water filtered. The 10-min tows were carried out following a saw-tooth pattern (Hempel, 1973) between the surface and a maximum depth of 50 m, or to within 5 m of the bottom at shallower stations. Once on deck, the nets were raised and rinsed with seawater. The plankton sample from the 333-micron mesh was preserved in a diluted buffered formaldehyde solution (4-5%) (Hunter, 1985) while that of the 500-micron mesh was placed in a concentrated ethanol solution (95%). A CTD instrument (Sea-Bird Electronics Inc.) was installed on the bongo sampler to obtain a profile of water temperature and salinity in the water column.

Plankton sorting was performed at the Fisheries and Oceans laboratory in Mont-Joli, Québec, during the fall of 2005. To reduce analysis time, each sample was split using the Van Guelpen beaker technique (Van Guelpen et al. 1982). The criteria used to identify fish eggs and larvae were mainly drawn from Fritzsche (1978), Elliott and Jimenez (1981), and Fahay (1983). The total length (Hardy, 1978) of capelin and herring larvae preserved in the formaldehyde solution was measured to within 0.01 mm. The larvae preserved in ethanol can be used later in growth studies based on otolith microstructure. Ethanol is used in this kind of study because, contrary to the formaldehyde solution, it does not cause bone structure decalcification (Shields and Carlson, 1996). The results of the sorting were input to data files and validated.

RESULTS

The survey was made from July 19 to 21, 2005. A total of 39 stations were sampled in the study area (Figure 2). The positions and depths of these stations are presented in Table 1 along with the duration of each tow and the volume of water filtered. The temperature profiles for each station are shown in Appendix 1. From the CTD profiles, mean temperatures and salinities were calculated by depth intervals of 2 m from 0 m to 20 m and by intervals of 5 m between 20 m and 60 m (Tables 2 and 3). Mean temperatures indicate a relative constancy in temperatures for the whole of the sampled area (Figure 3). However, starting from approximately 18-20 m, these temperatures fell quickly at offshore stations.

Fish eggs were found at each station (Appendix 2). The most abundant groups were CYT and CHW. The CYT group is associated with the eggs of cunner (*Tautogolabrus adspersus*) and yellowtail flounder (*Limanda ferruginea*) and the CHW group with those of cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*), and witch flounder (*Glyptocephalus cynoglossus*). Mackerel eggs (*Scomber scombrus* L.) were also found at each station. Mackerel egg stages were identified based on criteria presented in Girard (2000).

The larvae of 16 fish species were also found during the survey (Appendix 3). The most abundant were those of cunner, fourbeard rockling (*Enchelyopus cimbrus*), capelin (*Mallotus villosus*), righteye flounder (Pleuronectidae), and cod. Unlike the 2004 survey, very few herring larvae were sampled in 2005. The mean length of capelin larvae was 7.57 mm (n=550) (Table 4A) and the mean length of herring larvae was 12.71 mm (n=20) (Table 4B). Two main modes characterize the length frequency distribution of capelin larvae (Figure 4). For herring larvae, one main mode characterizes the length distribution that is also positively skewed.

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REFERENCES

Elliott, E. M., and D. Jimenez. 1981. Laboratory manual for the identification of ichthyoplankton from the Beverly - Salem Harbor area. Dept. of Fisheries, Wildlife and Recreational Vehicles. Massachusetts. 230 pp.

Fahay, M. P. 1983. Guide to the early stages of marine fishes occurring in the western North Atlantic Ocean, Cape Hatteras to the southern Scotian Shelf. J. Northwest Atl. Fish. Sci. 4: 1-423.

Fritzsche, R. A. 1978. Development of fishes of the Mid-Atlantic Bight: an atlas of egg, larval and juvenile stages. Vol. V. Chaetodontidae through Ophidiidae. U.S. Fish Wildl. Serv., Biol. Serv. Program FWS/OBS-78/12. 340 pp.

Girard, L. 2000. Identification of mackerel (*Scomber scombrus* L.) eggs sampled during abundance surveys in the southern Gulf of St. Lawrence. *In* The Atlantic mackerel (*Scomber scombrus* L.) of NAFO subareas 2 to 6, Chapter 4. Edited by F. Grégoire. CSAS Res. Doc. 2000/021, pp. 119-137.

Grégoire, F., W. Barry, J. Barry, L. Lefebvre, C. Lévesque, and J. Hudon. 2005. West coast of Newfoundland capelin (*Mallotus villosus* M.) and Atlantic herring (*Clupea harengus harengus* L.) larval survey, part 1: Description of the data collected in partnership with the industry (Barry Group) in July 2004. Can. Data Rep. Fish. Aquat. Sci. 1168(Part1): vi + 32 pp.

Grégoire, F., W. Barry, and J. Barry. 2006. West coast of Newfoundland capelin (*Mallotus villosus* M.) and Atlantic herring (*Clupea harengus harengus* L.) larval survey, part 2: Abundance estimates and marine community analyses of the data collected in partnership with the industry (Barry Group) in July 2004. Can. Tech. Rep. Fish. Aquat. Sci. 2650(Part2): viii + 50 pp.

Hardy, J. D. 1978. Development of fishes of the Mid-Atlantic Bight: an atlas of egg, larval and juvenile stages. Vol. II. Anguillidae through Syngnathidae. U.S. Fish Wildl. Serv., Biol. Serv. Program FWS/OBS-78/12. 458 pp.

Hempel, G. 1973. Fish egg and larval surveys. FAO Fisheries Technical Paper No. 122. 82 pp.

Hunter, J. R. 1985. Preservation of northern anchovy in formaldehyde solution. *In* An egg production method for estimating spawning biomass of pelagic fish: Application to the northern anchovy, *Eugraulis mordax*. Edited by R. Lasker. NOAA Technical Report NMFS 36, pp. 63-66.

Posgay, J. A., and R. R. Marak. 1980. The MARMAP Bongo zooplankton samplers. J. Northwest Atl. Fish. Sci. 1: 91-99.

Shields, A. S., and S. R. Carlson. 1996. Effects of formalin and alcohol preservation on lengths and weights of juvenile sockeye salmon. Alaska Fish. Res. Bull. 3(2):81-93.

Van Guelpen, L., D. F. Markle, and D. J. Duggan. 1982. An evaluation of accuracy, precision, and speed of several zooplankton sub-sampling techniques. J. Cons. Int. Explor. Mer. 40: 226-236.

Table 1. Description of the stations and tows completed during the capelin and Atlantic herring larval survey of July 2005.

STATION NUMBER	DATE (yyyy-mm-dd)	TIME OF THE DAY (hh:mm) (NDT)	LATITUDE °N (degrees minutes)	LONGITUDE °W (degrees minutes)	DEPTH Station bottom (m)	DEPTH Maximum sampled (m)	TOW DURATION (mm:ss)	VOLUME OF WATER FILTERED (m^3)
1	2005-07-19	11:39	49° 09'	58° 12'	115	44	11:20	235
2	2005-07-19	12:36	49° 12'	58° 12'	112	39	11:03	230
3	2005-07-19	18:56	49° 27'	58° 12'	20	12	10:31	276
4	2005-07-19	18:19	49° 30'	58° 12'	35	29	11:26	269
5	2005-07-19	17:43	49° 33'	58° 12'	60	33	12:16	287
6	2005-07-21	14:21	49° 06'	58° 18'	70	53	11:20	292
7	2005-07-21	13:47	49° 09'	58° 18'	125	33	13:00	319
8	2005-07-21	13:12	49° 12'	58° 18'	145	36	11:46	295
9	2005-07-19	13:25	49° 15'	58° 18'	80	58	12:33	258
10	2005-07-19	14:05	49° 18'	58° 18'	21	8	11:35	277
11	2005-07-19	15:34	49° 21'	58° 18'	35	26	10:34	246
12	2005-07-19	16:07	49° 24'	58° 18'	45	35	11:35	270
13	2005-07-19	16:40	49° 27'	58° 18'	54	38	12:20	282
14	2005-07-21	12:26	49° 09'	58° 24'	45	34	12:24	290
15	2005-07-19	21:22	49° 12'	58° 24'	40	30	11:41	267
16	2005-07-19	20:45	49° 15'	58° 24'	40	30	11:48	280
17	2005-07-19	14:49	49° 18'	58° 24'	30	17	10:26	251
18	2005-07-21	11:23	49° 03'	58° 30'	45	37	12:10	303
19	2005-07-20	8:57	49° 06'	58° 30'	80	47	13:00	222
20	2005-07-20	8:23	49° 09'	58° 30'	80	43	09:45	172
21	2005-07-20	7:46	49° 12'	58° 30'	65	35	11:12	230
22	2005-07-21	9:33	48° 51'	58° 36'	44	34	10:00	240
23	2005-07-21	10:08	48° 54'	58° 36'	20	12	10:25	260
24	2005-07-20	11:42	48° 57'	58° 36'	34	26	10:18	238
25	2005-07-20	11:02	49° 00'	58° 36'	50	29	11:53	280
26	2005-07-20	10:24	49° 03'	58° 36'	45	31	12:09	268
27	2005-07-20	9:42	49° 06'	58° 36'	50	33	09:40	213
28	2005-07-20	18:15	48° 39'	58° 42'	27	26	10:50	265
29	2005-07-20	17:22	48° 45'	58° 42'	25	13	10:35	260
30	2005-07-20	16:07	48° 48'	58° 42'	15	12	10:37	274
31	2005-07-20	15:34	48° 51'	58° 42'	17	10	10:55	260
32	2005-07-20	13:13	48° 54'	58° 42'	25	21	10:22	194
33	2005-07-20	12:35	48° 57'	58° 42'	30	20	09:46	187
34	2005-07-20	19:01	48° 36'	58° 48'	20	16	10:52	309
35	2005-07-20	19:35	48° 39'	58° 48'	20	10	10:25	266
36	2005-07-21	7:55	48° 42'	58° 48'	17	7	10:42	289
37	2005-07-20	14:44	48° 48'	58° 48'	27	25	11:07	214
38	2005-07-20	14:04	48° 51'	58° 48'	40	30	10:34	164
39	2005-07-20	20:31	48° 51'	58° 54'	15	8	10:37	266

Table 2. Mean water temperature (°C) by depth interval (m) for the stations sampled during the capelin and Atlantic herring larval survey of July 2005.

DEPTH	STATION																			
(m)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
0-2	16.34	---	14.17	14.02	13.97	15.95	15.47	15.51	14.92	14.73	14.30	14.21	14.15	15.32	14.89	14.75	14.53	15.36	14.30	---
2-4	15.17	14.90	14.11	13.86	13.92	15.74	15.32	14.98	14.55	14.71	14.00	14.13	14.06	15.10	14.80	14.58	14.36	15.08	14.23	14.00
4-6	14.64	14.85	14.06	13.70	13.80	15.49	15.12	14.68	14.40	14.51	13.90	14.11	13.94	14.65	14.63	14.14	14.23	14.96	14.21	13.95
6-8	14.02	14.49	13.98	13.42	13.17	15.28	15.00	14.65	14.25	14.29	13.83	14.00	13.48	14.37	14.34	13.76	14.09	14.90	14.19	13.89
8-10	13.58	13.72	13.95	13.20	13.01	15.14	14.93	14.46	14.25		13.53	13.73	13.29	14.22	13.45	13.35	13.99	14.79	14.08	13.85
10-12	13.06	12.57	13.76	12.95	12.98	15.03	14.79	14.41	14.20		13.45	13.27	13.20	14.11	12.65	12.52	13.82	14.63	14.01	13.63
12-14	12.52	12.23	13.46	12.89	12.92	14.81	14.65	14.30	13.60		12.56	12.54	12.87	14.02	12.14	12.12	13.82	14.33	13.90	13.39
14-16	12.23	11.46		12.44	12.50	14.59	14.59	14.17	12.56		12.09	11.99	12.25	13.93	11.98	11.96	13.20	14.24	13.61	12.91
16-18	11.84	10.55		12.00	11.87	13.97	14.49	13.40	11.97		11.81	11.62	11.40	13.89	11.72	11.68	12.47	14.10	12.73	12.35
18-20	11.35	10.16		11.73	10.84	13.50	14.30	12.17	11.16		11.63	11.34	11.11	13.57	11.24	10.94		14.01	12.16	11.76
20-25	10.20	9.83		10.46	9.10	13.09	11.83	10.47	10.04		10.88	10.51	10.22	11.90	10.57	9.63		13.21	11.69	11.17
25-30	8.42	8.28		8.55	7.21	12.50	9.18	8.03	7.98		10.31	8.89	8.39	7.92	8.86	7.86		9.04	10.29	10.38
30-35	5.96	6.22			5.97	9.57	6.39	6.08	5.72			5.95	5.59	4.06				6.76	8.04	9.09
35-40	4.26	4.81				5.73		4.71	4.04				3.94					4.25	5.06	5.44
40-45	3.45					4.09			3.39										3.31	3.28
45-50						3.36			2.72										2.48	
50-55						2.45			2.13											
55-60									1.88											

Table 2. (Continued).

DEPTH	STATION																		
(m)	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
0-2	13.99	14.63	14.55	13.96	15.38	14.97	14.79	16.72	15.79	15.79	14.33	14.08	14.01	16.87	16.52	16.59	14.39	---	16.12
2-4	13.98	14.44	14.22	13.88	15.37	14.91	14.72	16.59	15.80	15.43	14.07	14.02	13.96	16.48	16.36	16.56	14.32	13.85	15.77
4-6	13.98	14.41	13.97	13.84	15.34	14.85	14.66	16.58	15.83	15.19	13.86	13.83	13.63	15.21	15.89	15.92	14.18	13.79	14.74
6-8	13.95	14.38	13.81	13.82	15.31	14.74	14.46	16.44	15.72	14.81	13.60	13.43	13.39	13.54	14.84	15.38	13.75	13.63	13.65
8-10	13.62	14.31	13.76	13.82	15.05	14.68	14.07	15.64	15.59	14.38	13.38	13.04	13.31	12.51	14.23		13.32	13.47	
10-12	13.56	14.17	13.61	13.82	14.55	14.52	13.93	13.26	14.93	14.21	13.36	12.91	12.35	11.95			12.89	13.07	
12-14	13.52	14.06	13.49	13.81	14.27	14.25	13.85	12.02	13.97			11.69	11.95	11.71			11.85	12.00	
14-16	13.21	13.91		13.80	13.84	14.07	13.82	11.07				11.05	11.43	10.85			11.47	11.65	
16-18	12.16	13.65		13.78	13.44	14.01	13.78	10.55				10.30	10.68	10.49			11.24	11.52	
18-20	11.63	13.35		13.59	13.06	13.96	12.84	10.31				9.94	9.85				10.93	10.63	
20-25	11.22	11.51		11.30	11.33	13.16	11.40	9.38				9.59					9.90	9.82	
25-30	9.69	7.67		9.34	7.63	10.32	10.26	8.39									8.39	8.23	
30-35	6.62	5.47				7.81	9.04											7.75	
35-40	4.67																		
40-45																			
45-50																			
50-55																			
55-60																			

Table 3. Mean water salinity by depth interval (m) for the stations sampled during the capelin and Atlantic herring larval survey of July 2005.

DEPTH	STATION																			
(m)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
0-2	28.62	---	31.12	30.98	30.31	28.37	30.72	30.47	31.26	31.01	30.80	31.02	31.23	30.94	30.88	30.93	31.11	31.35	30.46	---
2-4	29.89	30.25	31.26	31.29	31.18	30.30	30.82	30.81	30.86	31.00	31.14	31.23	31.17	30.99	30.78	30.83	31.02	31.25	31.08	31.22
4-6	30.13	30.30	31.26	31.31	31.13	30.55	31.02	31.04	30.85	31.02	31.23	31.23	31.14	31.15	30.80	30.96	31.00	31.17	31.09	31.23
6-8	30.39	30.38	31.28	31.37	31.27	30.73	31.05	31.07	30.93	31.05	31.20	31.19	31.27	31.20	30.77	31.05	31.01	31.14	31.08	31.25
8-10	30.71	30.53	31.26	31.37	31.27	30.83	31.04	31.12	30.90		31.27	31.19	31.31	31.22	31.02	31.07	30.99	31.13	31.10	31.22
10-12	30.93	31.10	31.27	31.39	31.25	30.86	31.06	31.11	30.82		31.21	31.18	31.29	31.22	31.25	31.27	31.03	31.15	31.11	31.27
12-14	31.17	31.23	31.47	31.34	31.23	30.90	31.08	31.11	30.85		31.34	31.30	31.29	31.23	31.42	31.34	31.00	31.23	31.11	31.23
14-16	31.20	31.28		31.40	31.25	30.84	31.07	31.08	31.19		31.36	31.35	31.31	31.23	31.39	31.31	31.14	31.21	31.07	31.24
16-18	31.20	31.37		31.44	31.27	30.94	31.08	31.10	31.26		31.39	31.38	31.49	31.21	31.36	31.26	31.43	31.24	31.26	31.28
18-20	31.21	31.35		31.42	31.38	31.06	31.07	31.25	31.39		31.38	31.40	31.45	31.21	31.40	31.40		31.23	31.36	31.38
20-25	31.27	31.30		31.59	31.44	31.14	31.16	31.25	31.42		31.41	31.45	31.51	31.19	31.39	31.49		31.15	31.36	31.38
25-30	31.36	31.41		31.68	31.54	31.13	31.20	31.42	31.57		31.57	31.54	31.65	31.52	31.54	31.60		31.61	31.41	31.38
30-35	31.68	31.64			31.61	31.48	31.51	31.59	31.77			32.00	31.86	32.09				31.71	31.56	31.38
35-40	31.87	31.78				32.02		31.80	31.89				31.89					32.11	31.79	31.62
40-45	31.95					32.04			31.84										31.87	31.85
45-50						31.95			31.86										31.90	
50-55						32.00			31.88											
55-60									31.89											

Table 3. (Continued).

DEPTH	STATION																		
(m)	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
0-2	31.17	29.81	31.03	31.15	30.99	31.10	30.96	29.25	30.83	30.80	31.13	29.73	31.19	30.52	29.78	30.63	31.24	---	30.58
2-4	31.18	31.11	31.18	31.17	30.99	31.20	31.04	30.81	30.84	30.95	31.12	31.08	31.18	30.77	30.90	30.82	31.08	31.20	30.90
4-6	31.18	31.14	31.20	31.18	31.00	31.32	31.16	30.87	30.85	30.98	31.14	31.26	31.25	30.92	30.88	30.87	31.05	31.20	31.04
6-8	31.16	31.15	31.22	31.18	30.99	31.21	31.15	30.79	30.89	31.01	31.17	31.26	31.30	31.22	31.00	30.97	31.10	31.23	31.23
8-10	31.22	31.12	31.19	31.18	31.03	31.17	31.25	30.69	30.92	31.11	31.20	31.34	31.20	31.35	31.13		31.19	31.24	
10-12	31.22	31.16	31.21	31.18	31.18	31.20	31.24	31.26	30.97	31.19	31.19	31.15	31.33	31.40			31.17	31.22	
12-14	31.20	31.15	31.27	31.18	31.18	31.27	31.24	31.43	31.29			31.41	31.31	31.31			31.40	31.44	
14-16	31.20	31.18		31.18	31.22	31.25	31.23	31.54				31.41	31.33	31.39			31.41	31.47	
16-18	31.36	31.17		31.18	31.26	31.23	31.14	31.56				31.58	31.36	31.44			31.40	31.37	
18-20	31.42	31.21		31.13	31.19	31.22	31.26	31.51				31.59	31.51				31.43	31.48	
20-25	31.38	31.31		31.36	31.31	31.38	31.44	31.53				31.69					31.51	31.50	
25-30	31.37	31.77		31.80	31.68	31.76	31.44	31.80									31.85	31.56	
30-35	31.57	31.84				32.15	31.46											31.52	
35-40	31.87																		
40-45																			
45-50																			
50-55																			
55-60																			

Table 4. Descriptive statistics of the length measurements (mm) of capelin (A) and Atlantic herring (B) larvae sampled during the July 2005 survey.

(A)

STATION	Mean	Std. Dev.	Minimum	Maximum	Range	n
1	5.78	2.63	3.25	11.63	8.37	12
2	4.38	1.22	2.93	8.09	5.16	14
3	9.37	2.46	3.73	12.53	8.80	81
4	10.25	2.29	5.53	13.03	7.51	7
5	7.35	1.21	5.25	8.26	3.01	5
6	7.30	---	---	---	---	1
7	9.45	---	---	---	---	1
8	8.70	---	---	---	---	1
9	6.10	1.42	4.43	8.75	4.33	23
10	7.30	2.37	4.83	9.58	4.75	4
11	8.61	2.06	6.24	9.98	3.74	3
12	8.55	1.16	5.75	10.48	4.73	16
13	9.56	1.31	6.35	11.95	5.60	16
14	7.72	1.62	4.89	10.26	5.37	23
15	7.23	2.03	4.25	11.20	6.95	18
16	6.81	1.83	3.96	11.69	7.73	48
17	5.96	1.12	4.70	6.80	2.10	3
18	5.85	2.36	4.17	12.08	7.92	10
20	7.79	1.49	4.37	11.53	7.16	53
21	8.52	1.13	6.47	11.16	4.69	41
23	7.38	2.10	5.10	11.23	6.13	19
25	5.85	1.28	3.80	9.13	5.33	70
29	7.33	1.92	5.10	10.66	5.56	9
30	4.73	1.52	3.21	7.27	4.05	5
31	7.81	3.09	3.41	12.26	8.85	9
32	7.50	2.16	4.79	10.02	5.23	4
33	6.53	1.60	4.23	9.60	5.37	11
35	7.05	1.44	5.23	9.65	4.42	17
36	5.65	0.18	5.44	5.80	0.35	3
37	8.35	1.12	7.28	9.51	2.23	3
38	7.76	3.11	4.24	10.13	5.89	3
39	10.76	1.02	9.09	12.99	3.91	17
TOTAL	7.57	2.28	2.93	13.03	10.11	550

Table 4. (Continued).

(B)

STATION	Mean	Std. Dev.	Minimum	Maximum	Range	n
1	12.72	---	---	---	---	1
2	12.09	1.58	10.98	13.21	2.23	2
3	15.86	---	---	---	---	1
9	17.20	---	---	---	---	1
10	10.25	0.47	9.92	10.58	0.66	2
11	10.87	---	---	---	---	1
12	11.82	---	---	---	---	1
14	11.02	1.85	9.91	13.16	3.25	3
18	14.76	5.76	10.69	18.83	8.14	2
26	11.09	1.92	8.88	12.32	3.44	3
29	12.52	---	---	---	---	1
30	16.33	1.99	14.93	17.74	2.81	2
TOTAL	12.71	2.83	8.88	18.83	9.95	20

Figure 1. Map of the west coast of Newfoundland showing the study area and the other locations mentioned in the document.

Figure 1. Map of the west coast of Newfoundland showing the study area and the other locations mentioned in the document.

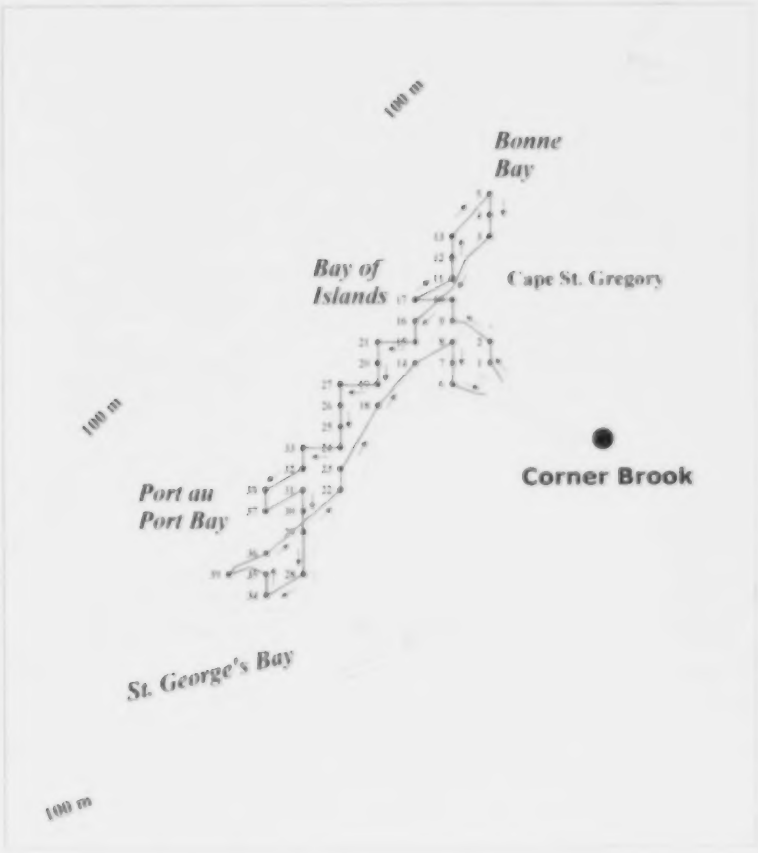


Figure 2. Map of the 39-station sampling grid of the capelin and Atlantic herring larval survey of July 2005.

Figure 3. Mean water temperature (°C) by depth intervals of 2 m from 0 m to 20 m and intervals of 5 m between 20 m and 60 m.

Figure 3. Mean water temperature (°C) by depth intervals of 2 m from 0 m to 20 m and intervals of 5 m between 20 m and 60 m.

Figure 3. (Continued).

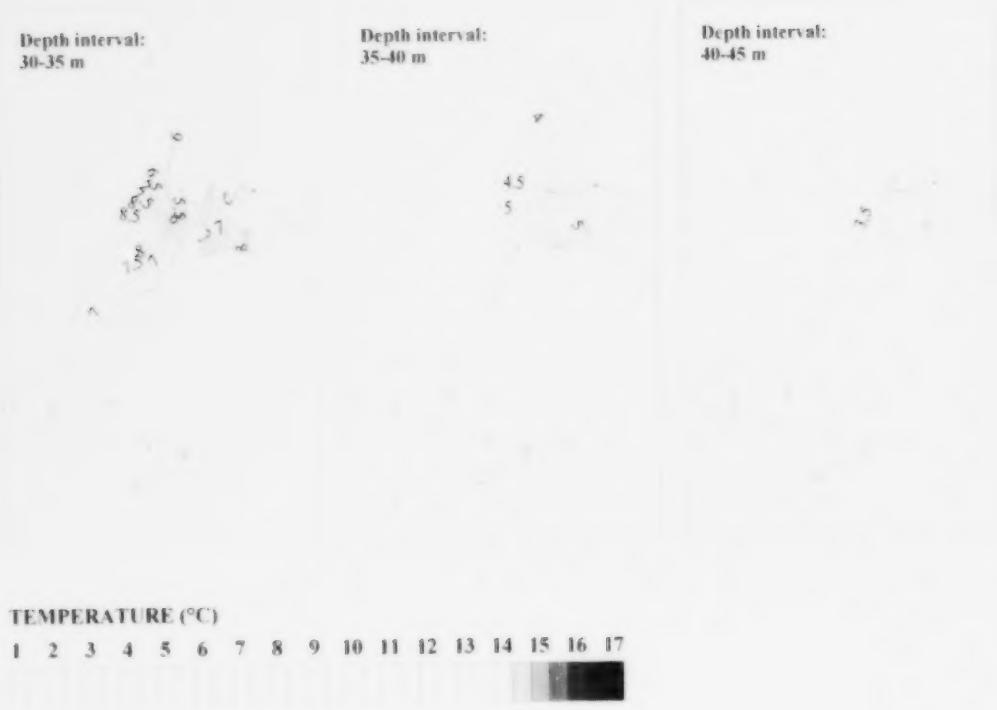


Figure 3. (Continued).

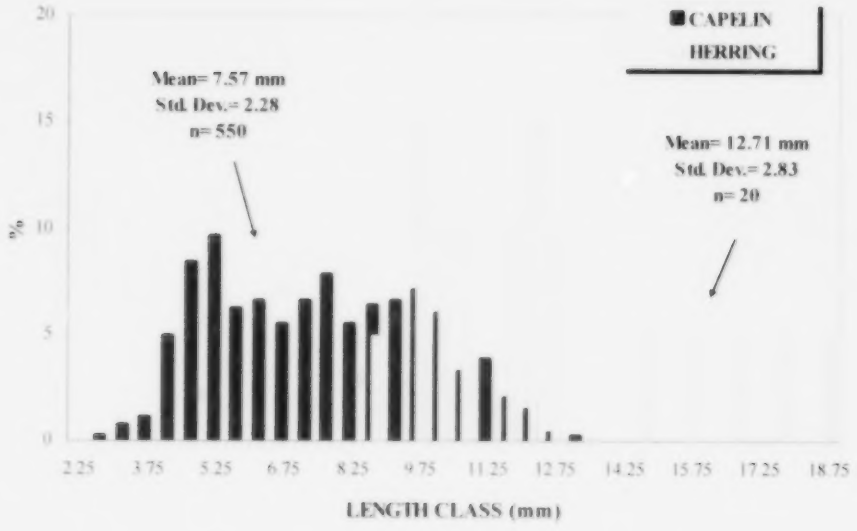
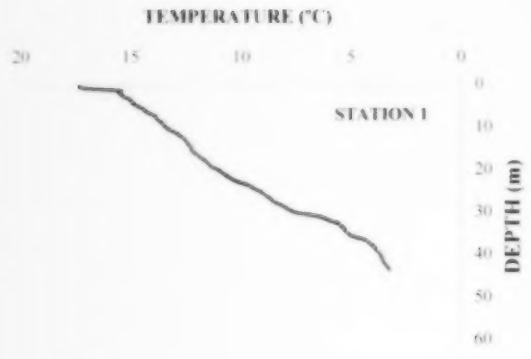
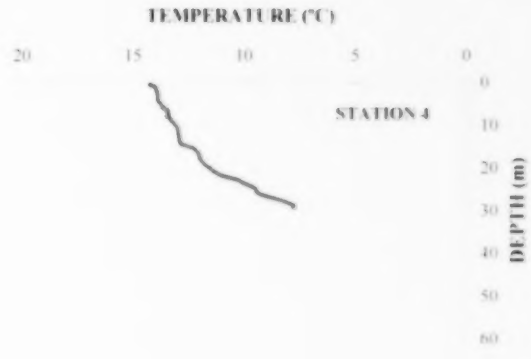
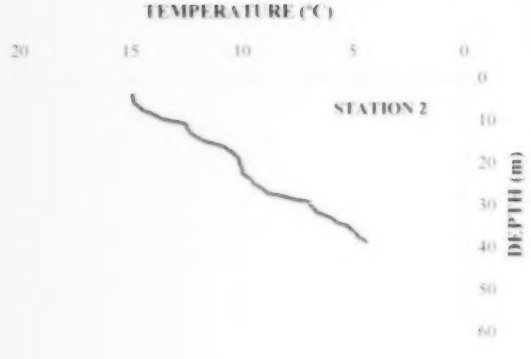


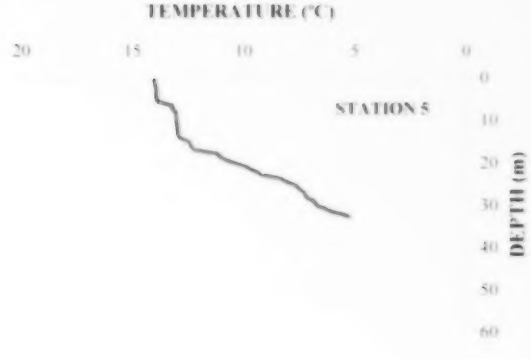
Figure 4. Length (mm) frequency distributions of capelin and Atlantic herring larvae sampled during the July 2005 survey.

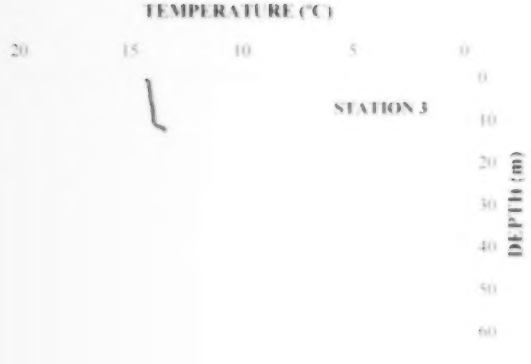
Appendix 1. Temperature profiles for stations sampled during the capelin and Atlantic herring larval survey of July 2005 on the west coast of Newfoundland.

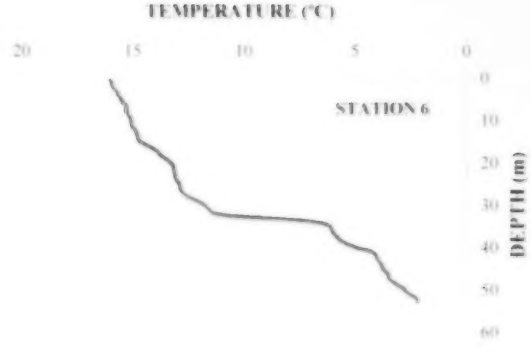

TEMPERATURE (°C)
20
15
10
5
0
STATION 1
0
10
20
30
40
50
60
DEPTH (m)

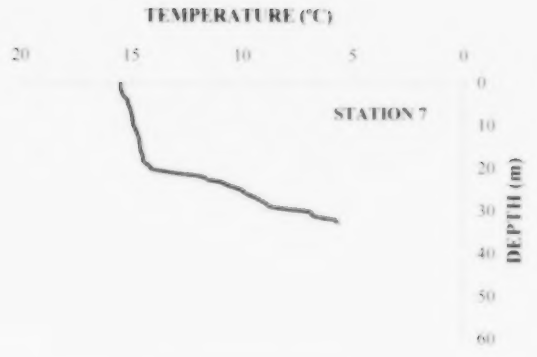

TEMPERATURE (°C)
20
15
10
5
0
STATION 4
0
10
20
30
40
50
60
DEPTH (m)

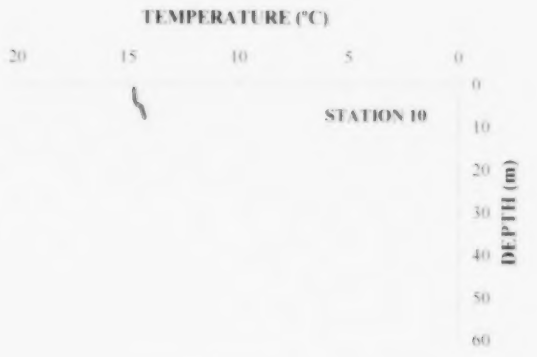

TEMPERATURE (°C)
20
15
10
5
0
STATION 2
0
10
20
30
40
50
60
DEPTH (m)

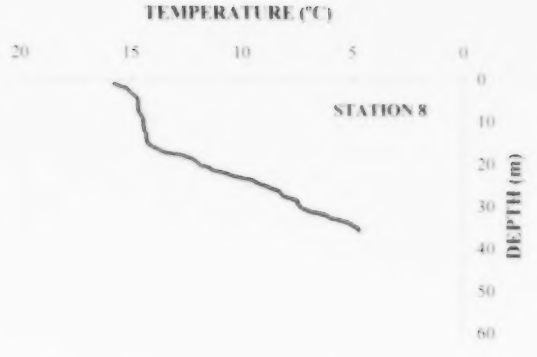

TEMPERATURE (°C)
20
15
10
5
0
STATION 5
0
10
20
30
40
50
60
DEPTH (m)

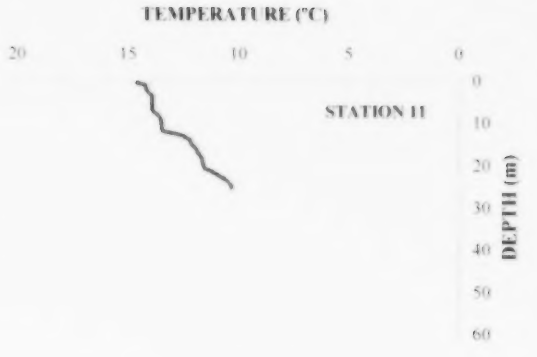

TEMPERATURE (°C)
20
15
10
5
0
STATION 3
0
10
20
30
40
50
60
DEPTH (m)

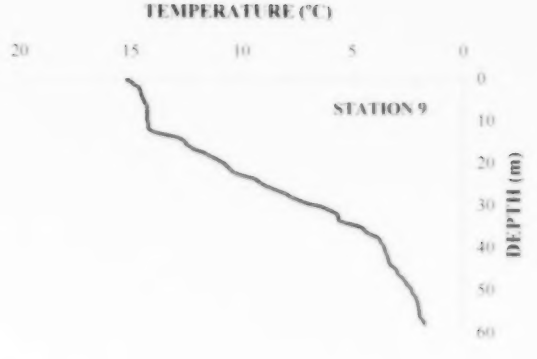

TEMPERATURE (°C)
20
15
10
5
0
STATION 6
0
10
20
30
40
50
60
DEPTH (m)

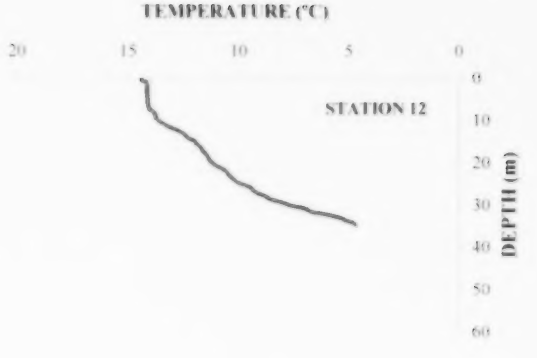

TEMPERATURE (°C)
20
15
10
5
0
STATION 7
0
10
20
30
40
50
60
DEPTH (m)

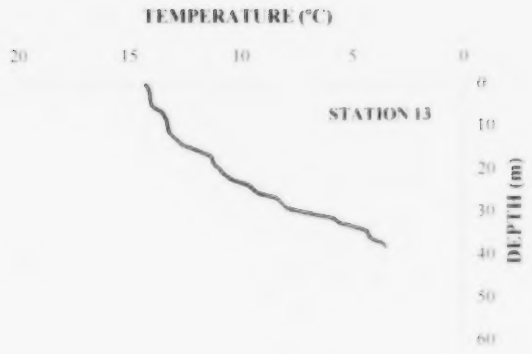

TEMPERATURE (°C)
20
15
10
5
0
STATION 10
0
10
20
30
40
50
60
DEPTH (m)

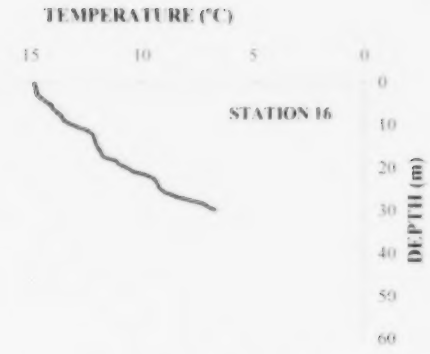

TEMPERATURE (°C)
20
15
10
5
0
STATION 8
0
10
20
30
40
50
60
DEPTH (m)

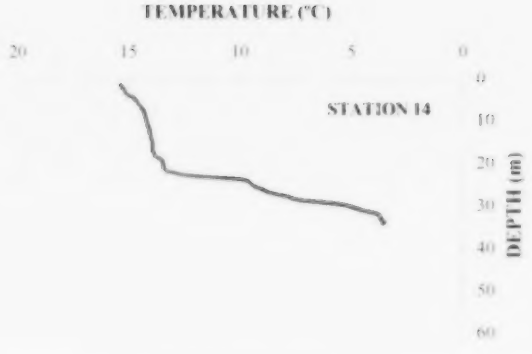

TEMPERATURE (°C)
20
15
10
5
0
STATION 11
0
10
20
30
40
50
60
DEPTH (m)

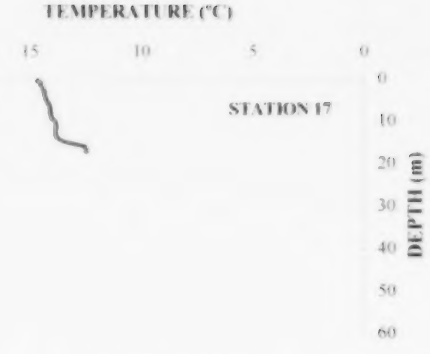

TEMPERATURE (°C)
20
15
10
5
0
STATION 9
0
10
20
30
40
50
60
DEPTH (m)

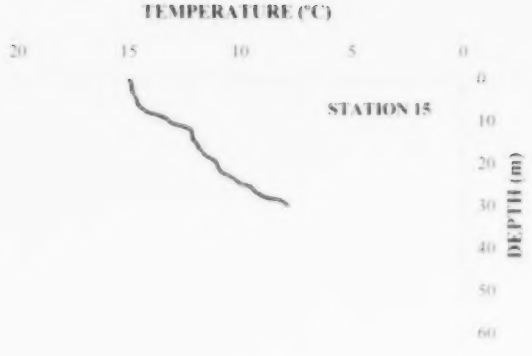

TEMPERATURE (°C)
20
15
10
5
0
STATION 12
0
10
20
30
40
50
60
DEPTH (m)

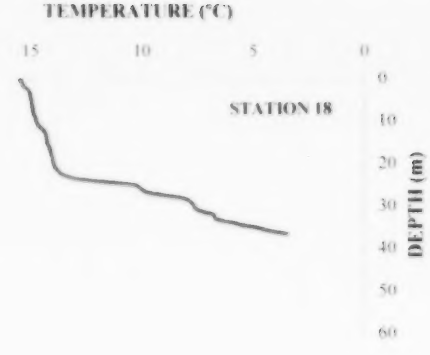

TEMPERATURE (°C)
20
15
10
5
0
STATION 13
0
10
20
30
40
50
60
DEPTH (m)

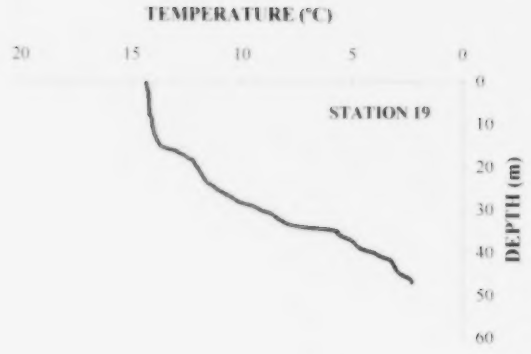

TEMPERATURE (°C)
20
15
10
5
0
STATION 16
0
10
20
30
40
50
60
DEPTH (m)

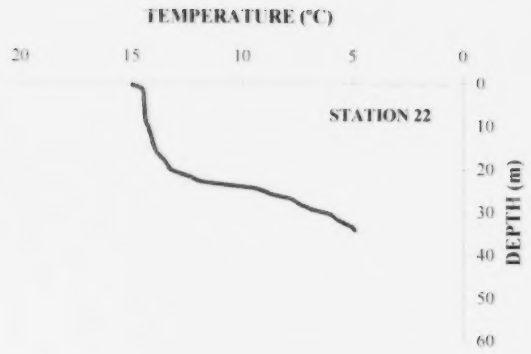

TEMPERATURE (°C)
20
15
10
5
0
STATION 14
0
10
20
30
40
50
60
DEPTH (m)


TEMPERATURE (°C)
20
15
10
5
0
STATION 17
0
10
20
30
40
50
60
DEPTH (m)


TEMPERATURE (°C)
20
15
10
5
0
STATION 15
0
10
20
30
40
50
60
DEPTH (m)


TEMPERATURE (°C)
20
15
10
5
0
STATION 18
0
10
20
30
40
50
60
DEPTH (m)


TEMPERATURE (°C)
20
15
10
5
0
STATION 19
0
10
20
30
40
50
60
DEPTH (m)


TEMPERATURE (°C)
20
15
10
5
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STATION 22
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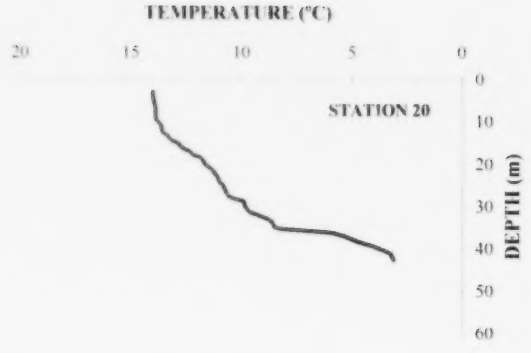
DEPTH (m)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STATION 20
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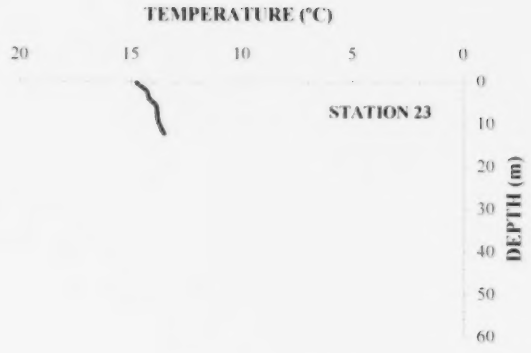
DEPTH (m)


TEMPERATURE (°C)
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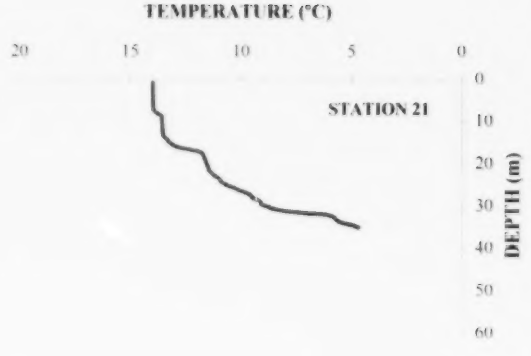
DEPTH (m)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STATION 21
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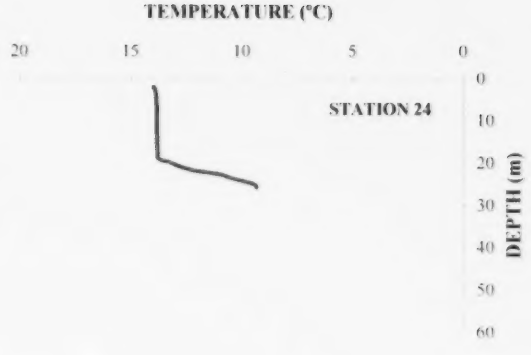
DEPTH (m)


TEMPERATURE (°C)
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STATION 24
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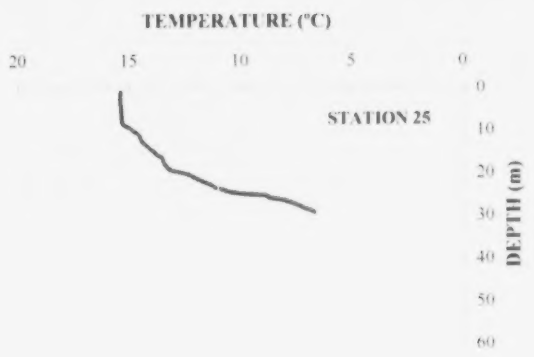
20
30
40
50
60
DEPTH (m)


TEMPERATURE (°C)
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5
0
STATION 25
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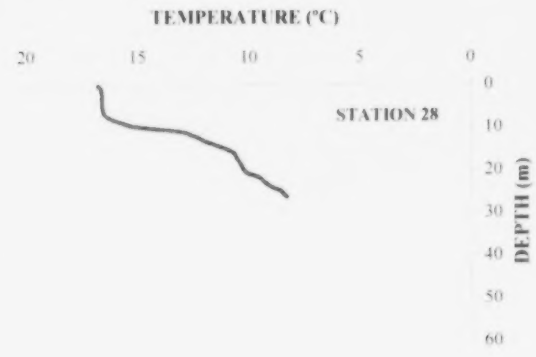
10
20
30
40
50
60
DEPTH (m)


TEMPERATURE (°C)
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15
10
5
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STATION 28
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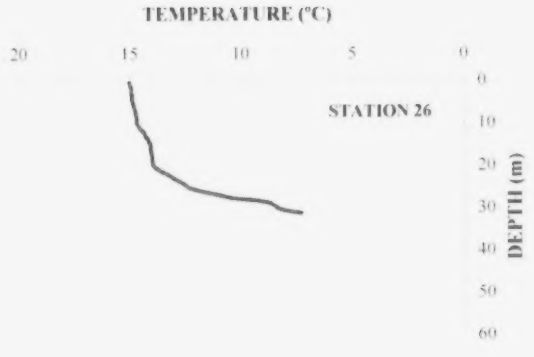
10
20
30
40
50
60
DEPTH (m)


TEMPERATURE (°C)
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15
10
5
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STATION 26
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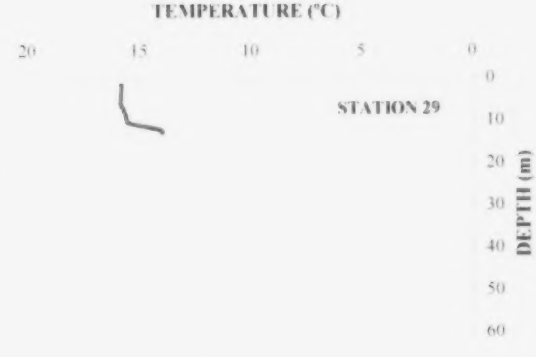
10
20
30
40
50
60
DEPTH (m)


TEMPERATURE (°C)
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15
10
5
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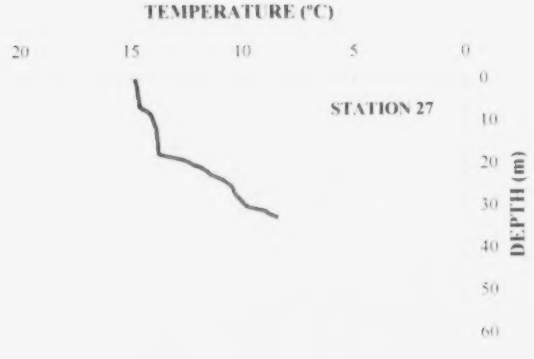
STATION 29
0
10
20
30
40
50
60
DEPTH (m)


TEMPERATURE (°C)
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15
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5
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STATION 27
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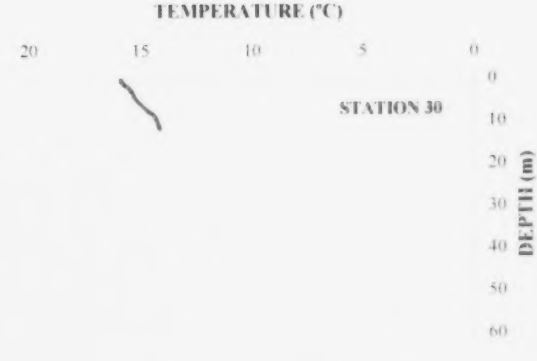
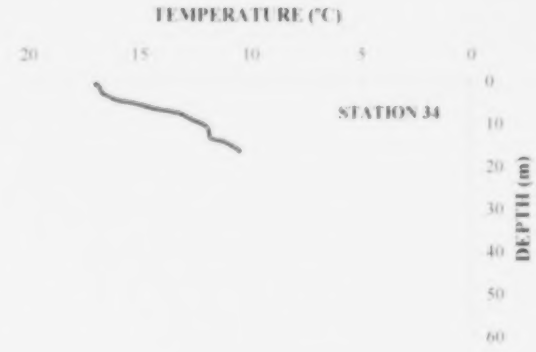
10
20
30
40
50
60
DEPTH (m)


TEMPERATURE (°C)
20
15
10
5
0
STATION 30
0
10
20
30
40
50
60
DEPTH (m)

TEMPERATURE (°C)
20
15
10
5
0
STATION 31
0
10
20
30
40
50
60
DEPTH (m)


TEMPERATURE (°C)
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15
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5
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STATION 34
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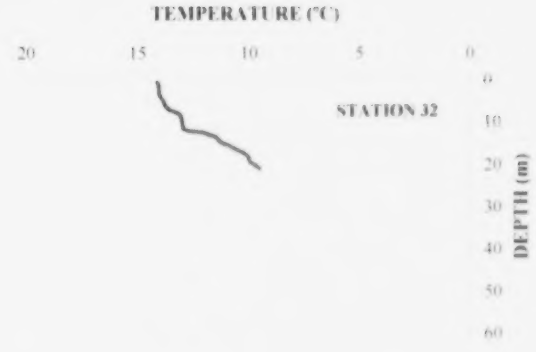
10
20
30
40
50
60
DEPTH (m)


TEMPERATURE (°C)
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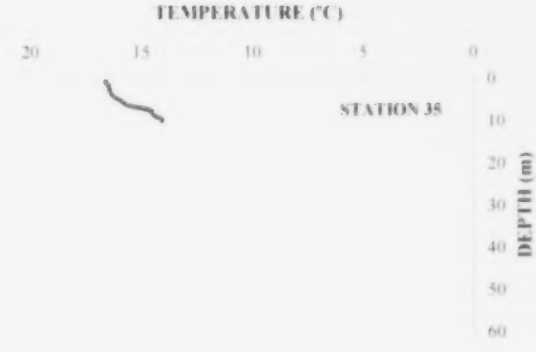
15
10
5
0
STATION 32
0
10
20
30
40
50
60
DEPTH (m)


TEMPERATURE (°C)
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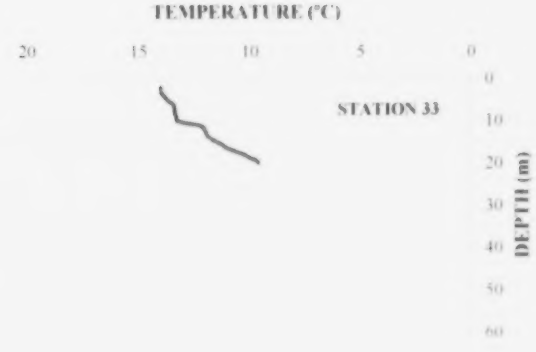
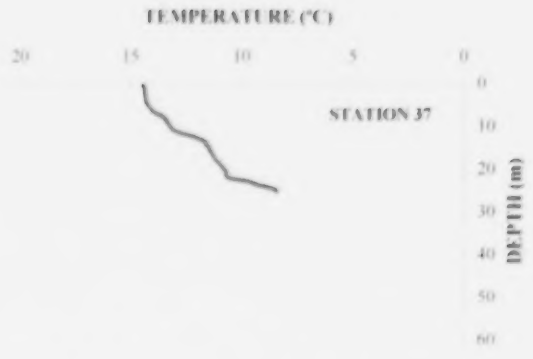
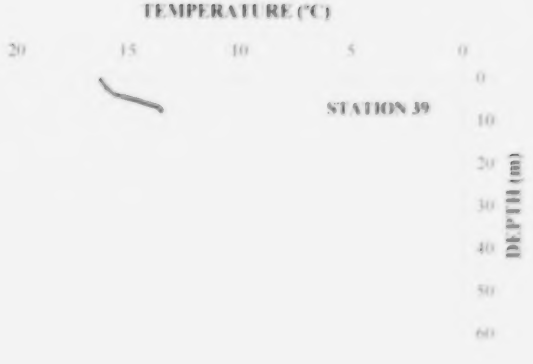
15
10
5
0
STATION 35
0
10
20
30
40
50
60
DEPTH (m)


TEMPERATURE (°C)
20
15
10
5
0
STATION 33
0
10
20
30
40
50
60
DEPTH (m)

TEMPERATURE (°C)
20
15
10
5
0
STATION 36
0
10
20
30
40
50
60
DEPTH (m)


TEMPERATURE (°C)
20
15
10
5
0
STATION 37
0
10
20
30
40
50
60
DEPTH (m)

TEMPERATURE (°C)
20
15
10
5
0
STATION 38
0
10
20
30
40
50
60
DEPTH (m)


TEMPERATURE (°C)
20
15
10
5
0
STATION 39
0
10
20
30
40
50
60
DEPTH (m)

Appendix 2. Volume of the plankton sample (ml) and number of eggs sorted and identified from the samples collected during the capelin and Atlantic herring larval survey of July 2005 on the west coast of Newfoundland. Egg codes are as follows: H4B = hake (*Urophycis* sp.), fourbeard rockling (*Enchelyopus cimbrius*), and butterfish (*Peprilus triacanthus*); CHW = cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*), and witch flounder (*Glyptocephalus cynoglossus*); CYT = cunner (*Tautogolabrus adspersus*) and yellowtail flounder (*Limanda ferruginea*).

Descriptions and pictures of mackerel eggs are found in Girard (2000).

STATION	SAMPLE VOLUME (ml)	EGGS (n)									
		MACKEREL					H4B	CHW	CYT	American plaice *(Hippoglossoides platessoides)*	Windowpane *(Scophthalmus aquosus)*
		Stage 1	Stage 2	Stage 3	Stage 4	Stage 5					
1	85	8	4	11	5	0	8	112	528	0	0
2	70	24	22	16	12	3	32	168	1640	8	0
3	80	184	35	38	14	10	80	64	4504	0	0
4	70	58	4	7	1	6	6	346	8	0	0
5	110	37	0	9	2	3	6	222	0	0	0
6	60	27	12	40	39	1	16	46	968	0	0
7	80	67	13	16	7	1	0	78	3688	2	0
8	70	41	37	41	25	6	80	128	944	0	0
9	80	80	8	58	18	0	8	72	344	1	0
10	70	175	9	19	12	1	32	40	14656	0	0
11	40	79	3	9	5	1	0	240	56	1	0
12	80	55	3	5	6	1	0	224	0	0	0
13	70	29	7	3	0	2	12	298	0	0	0
14	85	66	36	27	9	8	18	140	2792	0	2
15	80	47	42	36	14	2	8	192	216	1	0
16	60	26	18	46	24	0	2	68	234	0	0
17	35	128	42	42	24	12	48	16	384	0	0
18	60	60	35	37	8	1	16	44	2512	0	0
19	100	11	2	3	4	2	0	352	96	0	0
20	70	3	2	7	5	0	0	200	0	0	0
21	90	8	2	3	1	0	0	176	0	0	0
22	40	16	13	10	4	0	14	0	2392	0	0
23	60	78	28	17	5	0	5	2	2384	0	0
24	70	91	10	7	10	2	10	10	2856	0	0
25	90	112	8	46	28	6	0	16	3848	0	0
26	40	45	9	18	18	1	0	96	1088	0	0
27	50	13	13	3	14	1	8	136	96	1	0
28	100	12	8	5	1	1	536	16	3128	0	0

STATION	SAMPLE VOLUME (ml)	EGGS (n)									
		MACKEREL					H4B	CHW	CYT	American plaice *(Hippoglossoides platessoides)*	Windowpane *(Scophthalmus aquosus)*
		Stage 1	Stage 2	Stage 3	Stage 4	Stage 5					
29	80	23	6	5	6	4	320	0	3320	0	0
30	60	46	4	2	3	1	144	10	5608	0	0
31	70	11	7	8	3	1	0	4	2864	0	0
32	40	22	13	15	5	0	0	12	12	0	0
33	70	8	5	7	5	0	0	12	12	0	0
34	140	5	2	1	0	1	616	2	360	0	8
35	75	8	2	4	5	0	512	0	352	0	0
36	75	6	2	4	3	0	640	0	1760	0	0
37	110	11	11	4	5	0	0	44	400	0	0
38	80	2	1	2	3	0	0	46	11	0	0
39	100	1	0	0	0	0	1056	0	88	0	0

Appendix 3. Number of larvae sorted and identified from the samples collected during the capelin and Atlantic herring larval survey of July 2005 on the west coast of Newfoundland. Scientific names are as follows: mackerel (*Scomber scombrus*), sand lance (*Ammodytes* sp.), herring (*Clupea harengus harengus*), cod (*Gadus morhua*), American plaice (*Hippoglossoides platessoides*), snailfish (*Liparis* sp.), capelin (*Mallotus villosus*), redfish (*Sebastes* sp.), arctic shanny (*Stichaeus punctatus*), radiated shanny (*Ulvaria subbifurcata*), fourbeard rockling (*Enchelyopus cimbrius*), witch flounder (*Glyptocephalus cynoglossus*), winter flounder (*Pseudopleuronectes americanus*), righteye flounder (Pleuronectidae), cunner (*Tautogolabrus adspersus*), windowpane flounder (*Scophthalmus aquosus*), broken larvae, other larvae not identified.

STATION	Mackerel	Sand Lance	Herring	Cod	American plaice	Snailfish	Capelin	Redfish	Arctic shanny	Radiated shanny	Fourbeard rockling	Witch flounder	Winter flounder	Righteye flounder
1	1	0	0	4	0	1	13	0	0	0	3	0	0	17
2	0	0	1	2	0	0	13	0	0	0	1	0	1	2
3	14	2	2	20	0	0	162	0	6	4	48	0	44	30
4	0	0	0	4	0	0	7	0	3	0	4	0	2	9
5	0	0	0	3	0	1	4	0	0	0	0	0	3	6
6	9	0	1	0	0	0	3	0	0	0	8	0	0	16
7	21	0	0	2	0	0	6	1	0	0	24	0	16	2
8	20	0	2	4	0	0	19	2	0	0	40	16	24	0
9	2	0	1	0	0	0	26	1	0	0	4	0	2	4
10	8	0	2	8	0	0	4	0	0	1	12	0	0	0
11	7	0	1	6	0	0	4	0	0	0	5	0	0	3
12	7	0	1	41	0	0	20	0	0	0	7	0	0	31
13	0	0	0	28	0	0	16	0	0	0	2	0	0	66
14	34	0	3	70	6	0	31	0	0	1	30	12	10	24
15	0	0	0	22	0	0	19	0	0	0	4	0	8	4
16	12	0	0	18	0	0	49	0	0	0	6	8	0	8
17	9	0	0	0	0	0	3	0	0	0	4	0	0	0
18	51	0	2	4	0	0	11	0	0	0	42	2	0	0
19	4	1	0	26	0	0	26	0	0	0	14	0	0	40
20	1	0	0	38	0	0	27	0	0	0	2	0	0	0
21	4	0	0	58	0	0	44	0	0	0	8	0	0	168
22	17	0	0	8	0	0	5	0	0	5	23	0	3	3
23	18	0	0	6	0	0	30	0	0	14	23	1	0	12
24	2	0	0	0	0	0	31	0	0	2	16	0	0	8
25	5	0	0	0	0	0	98	0	0	0	48	0	0	8
26	8	0	3	16	0	0	21	0	0	0	16	16	0	48
27	3	0	0	64	0	0	17	0	0	4	16	0	0	32
28	4	0	0	0	0	0	5	0	0	0	112	0	0	0

STATION	Cunner	Windowpane flounder	Broken larvae	Other larvae not identified
1	5	0	1	0
2	37	0	0	0
3	90	0	0	0
4	0	0	0	0
5	2	0	0	3
6	432	8	0	0
7	544	0	6	14
8	400	2	8	0
9	144	0	0	0
10	680	0	0	0
11	376	0	1	2
12	38	0	1	7
13	2	0	0	0
14	640	0	1	4
15	160	0	0	0
16	146	0	0	2
17	728	0	1	0
18	1304	6	2	0
19	28	1	0	1
20	48	1	2	5
21	216	0	0	2
22	163	1	3	3
23	320	2	1	1
24	200	20	2	1
25	296	0	0	0
26	0	0	0	6
27	104	8	0	1
28	2032	8	0	0

STATION	Mackerel	Sand Lance	Herring	Cod	American plaice	Snailfish	Capelin	Redfish	Arctic shanny	Radiated shanny	Fourbeard rockling	Witch flounder	Winter flounder	Righteye flounder
29	9	0	1	0	0	0	5	0	0	2	288	0	0	0
30	6	0	2	0	0	0	10	0	0	6	72	0	0	4
31	1	0	0	1	0	0	4	0	0	3	8	0	0	16
32	0	0	0	0	0	0	12	0	0	4	0	16	2	0
33	0	0	0	6	0	0	26	2	0	2	2	4	0	0
34	0	0	8	0	0	0	5	0	1	0	64	0	0	8
35	2	0	0	0	0	0	0	0	0	0	152	0	0	0
36	5	0	1	0	0	0	0	0	0	1	72	0	0	0
37	1	0	0	12	0	0	3	0	0	0	4	16	0	12
38	0	0	0	18	0	0	3	0	0	0	0	0	0	32
39	2	0	0	0	0	0	17	0	0	0	40	0	0	0

STATION	Cunner	Windowpane flounder	Broken larvae	Other larvae not identified
29	1544	16	0	4
30	584	8	0	2
31	872	16	0	0
32	2	0	1	0
33	4	2	0	5
34	640	0	0	4
35	1496	56	24	0
36	736	64	1	0
37	64	0	0	1
38	0	0	0	3
39	64	24	0	0